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# Influence of sleep timing behavior on weight status and activity patterns in adults with intellectual disabilities

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ABSTRACT

The aim was to explore the relationship between sleep habits and overweight/obesity, physical activity and sedentary behaviors in French adults with intellectual disabilities. This observational study was conducted on 570 French adults with intellectual deficiency. Sleep habits were analyzed and related to anthropometric measures, physical activity and sedentary behaviors. The study was conducted using a self-administered questionnaire. Participants completed the questionnaire during an interview with the principal investigator. Sleep timing behavior was classified into 4 sleep patterns: Early-bed/Early-rise, Early-bed/Late-rise, Late-bed/Late-rise, and Late-bed/Early-rise. Of 570 eligible participants, 61 were excluded because of missing data on age, weight or height. The number of participants identified in each of the four sleep patterns was as follows: Early-bed/Early-rise, $N = 119$ (23%), Early-bed/Late-rise, $N = 171$ (34%), Late-bed/Early-rise, $N = 100$ (20%), Late-bed/Late-rise $N = 119$ (23%). Participants who wake up earlier are more active than those who rise late ($p < 0.02$). Participants who slept later spent more time in sedentary activities than those in the Early rise groups ($p < 0.01$). The number of obese/overweight participants was also higher in Late-bed/Late rise group. Sleep behavior was associated with overweight/obesity, physical activity and sedentary behavior in adults with intellectual deficiency, independently the sleep duration. Implementing intervention or promotion programs on sleep behaviors should be considered in order to meet the objectives of promoting health on anthropometric characteristics and increased physical activity among these disabled adults.



## 1. Introduction

Overweight and obesity continue to attract worldwide concern in developing public health policy. The prevalence of obesity has tripled since thirty years in European countries, and continues to rise at an alarming rate (WHO, 2009). Equally

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alarming is the high percentage of overweight and obese in population with intellectual disabilities. Many studies showed a higher prevalence of overweight and obesity in intellectually disabled adults compared to non-disabled adults (Hove, 2004; Mikulovic et al., 2014; Rimmer & Yamaki, 2006; Robertson et al., 2000; Stedman & Leland, 2010). Regarding the consequences of obesity (diabetes, cardiovascular diseases, cancer, and increased early mortality) and its high cost associated, estimated in Europe at roughly €33 billion a year (Berenson et al., 1998; Fair & Montgomery, 2009; Fry & Finley, 2005), it is necessary to develop a better understanding on the health problems in disabled adults and policies to develop in a near future.

Overweight and obesity are pathologies marked by an increase of body fat as a consequence of a positive energy balance, when energy intake exceeds energy expenditure, over a prolonged period of time. By this definition, intervention to treat obesity should include nutrition and physical activity. However, other factors have to be taken into consideration, particularly the societal changes. Increasing in television viewing and Internet use has an important impact on sleep patterns, leading to chronic sleep deprivation. Indeed, patterns of reduced sleep duration have been reported simultaneously with patterns of increased obesity (Van Cauter & Knutson, 2008). The relationship between short sleep duration and obesity has been widely demonstrated (Cappuccio et al., 2008; Knutson, 2005; Patel & Hu, 2008). However, sleep-timing behavior may also be a better predictor of overweight and obesity than sleep duration alone (Fleig & Randler, 2009; Gaina et al., 2006; Olds, Maher, & Matricciani, 2011; Schubert & Randler, 2008). These studies demonstrated that sleep habits were associated with an unfavorable activity and weight status profile, independent of age, sex, household income, geographical remoteness, and sleep duration in people with no intellectual disabilities. Recently, a study in French adolescents with intellectual disabilities showed the higher number of adolescents who were sedentary was those in Late rise vs. Early rise participants and participants in the Late-bed group were more likely overweight and obese, independently the sleep duration (Vanhelst, Bui-Xuan, Fardy, & Mikulovic, 2013). Today, there is no study on this topic in adults with intellectual disabilities.

Therefore, the objective of this study was to explore whether sleep timing behavior was related to overweight/obesity, physical activity and sedentary behavior among French adults with intellectual disabilities.

## 2. Methods

### 2.1. Study design

The participants included in the study were institutionalized intellectual deficiency adults, hosted in working centers, occupational institutes, foster homes or medical foster homes. The study was conducted in cooperation with five French Universities (Lyon, Strasbourg, Montpellier, Nice and Dunkirk). Students doing the degree course in Adapted Physical Exercise participated in data collection as interviewers. All institutions for intellectual deficiency adults near these five cities that hosted students for a training period were asked to participate in the study. All responded positively. Ten intellectual deficiency people were randomly selected per institution, to balance the relative statistical weight of each institution and prevent any ''institution'' effect. Participants younger than 18 and older than 60 years were excluded. Before the study began, the purpose and objectives were carefully explained to each participant and legal tutors. Written informed consent was obtained. Participation in the study was voluntary. All procedures were performed in accordance with the ethical standards of the Helsinki Declaration of 1975 as revised in 2008 and with European Good Clinical Practices (Béghin et al., 2008).

Each participant participated in a face-to-face interview with a student who completed the questionnaire, in the presence of a professional working in the institution (physician, educator or nurse). Factual data (such as the time spent doing sporting activities) were reported by the professionals accompanying the intellectual deficiency participants. The intellectual deficiency participants themselves answered personal questions (body representation, self-esteem, eating habits, etc.). All participants attending the institutions were capable of answering the questionnaire. No exclusion criteria were applied before randomization.

### 2.2. Measurements

Measurements included physical characteristics and lifestyle habits. Data were collected anonymously.

#### 2.2.1. Participant characteristics

Body mass was measured without shoes and heavy outer garments to the nearest 0.1 kg using an electronic scale (Seca, Hamburg, Germany). Height was measured without shoes to the nearest 0.1 cm using a standard physician's scale. Body Mass Index (BMI) was calculated by weight (kg)/height ($m^2$). BMI $\leq$18.5, $\geq$25 and $\geq$30 $kg/m^2$ defines underweight, overweight and obesity, respectively (de Onis & Habicht, 1996). Participants were assigned to respective weight categories according to BMI scores.

#### 2.2.2. Lifestyle habits

A questionnaire was used that had been developed previously for non-intellectual deficiency adolescents (Thibault, Contrand, Saubusse, Baine, & Maurice-Tison, 2010). In order to know if this questionnaire can be extrapolated to intellectual

deficiency adults, two pre tests were performed. Prior to data collection, an initial pretest questionnaire was completed by a sample of 10 adults with intellectual deficiency. This pretest was conducted to evaluate clarity and comprehensiveness of each question, as well as the amount of time necessary to complete the questionnaire. A second pretest was completed by a sample of 15 intellectual deficiency adults to assess the quality and response rate for each question. Questions were deleted if they were completed by less than 80% of participants.

The questionnaire was divided in four parts: (i) physical activity was assessed from the number of weekly hours of exercise or sports. Participants were asked to report separately on duration and type of sport practice, whether in leisure time, or inside sport clubs. The answers were summed to establish a total cumulative time spent on physical activity per week; (ii) sedentary behavior was estimated by the amount of time spent each week watching television, using a computer, and playing video games. (iii) Sleep habits were based on sleep-timing behavior and duration of sleep. Sleep-timing was classified as follows: Early to bed early to rise (Early-bed/Early-rise), early to bed late to rise (Early-bed/Late-rise), late to bed late to rise (Late-bed/Late-rise), and late to bed early to rise (Late-bed/Early-rise) (Olds et al., 2011; Putilov, 2008). Sleep duration was calculated from time to bed and time to rise data.

### 2.3. Statistical analysis

Data were analyzed using the Statistical Package for the Social Sciences, Windows 11.5 (SPSS Inc., Chicago, IL, USA), Excel 2003 (Microsoft Inc., Redmond, WA, USA) and Sphinx (Chavanod, France).

Differences in mean values were assessed using ANOVA testing. Chi-square was used to test differences in categorical variables. Multivariate logistic regressions were used to assess the relationships between sleep patterns and physical characteristics and lifestyle habits. Sleep duration and weight status were entered as confounding factors. A $p$ value $<0.05$ was chosen as the level of significance.

## 3. Results

### 3.1. Sleep patterns

Bedtimes, wake up times and sleep durations are compared across the four categories of sleep timing in Table 1 and Fig. 1. The number of participants in each group was as follows: Early-bed/Early-rise group, $N = 119$ (23%), Early-bed/Late-rise group, $N = 171$ (34%), Late-bed/Early-rise, $N = 100$ (20%), and Late-bed/Late-rise, $N = 119$ (23%). Participants in the Early-bed/Early-rise and Late-bed/Early-rise groups woke 84–94 min earlier than the Late rise groups. Participants of the Early bed groups went to bed in average 97 min earlier than the late to bed groups. Significant differences were observed between bed and wake up time ($p < 0.01$) and in sleep duration ($p < 0.01$) (Table 1).

**Table 1**
Data on bedtimes, wake up times and sleep durations across different categories in adults (mean ± SD).

| | Model 1 | Model 2 | Model 3 | Model 4 | *P* |
|---|---|---|---|---|---|
| *N* | 119 | 171 | 100 | 119 | |
| Bedtime (h,mn) | 9:19 PM ± 44 min | 9:19 PM ± 46 min | 10:57 PM ± 45 min | 10:56 PM ± 40 min | 0.01 |
| Wake up time (h,mn) | 6:08 AM ± 32 min | 7:42 AM ± 58 min | 6:10 AM ± 45 min | 7:34 AM ± 57 min | 0.01 |
| Sleep duration (h,mn) | 6.82 ± 0.43 | 8.30 ± 0.46 | 6.87 ± 0.39 | 8.24 ± 0.43 | 0.01 |

Model 1: Early-bed/Early-rise, model 2: Early-bed/Late-rise, model 3: Late-bed/Early-rise, model 4: Late-bed/Late-rise.

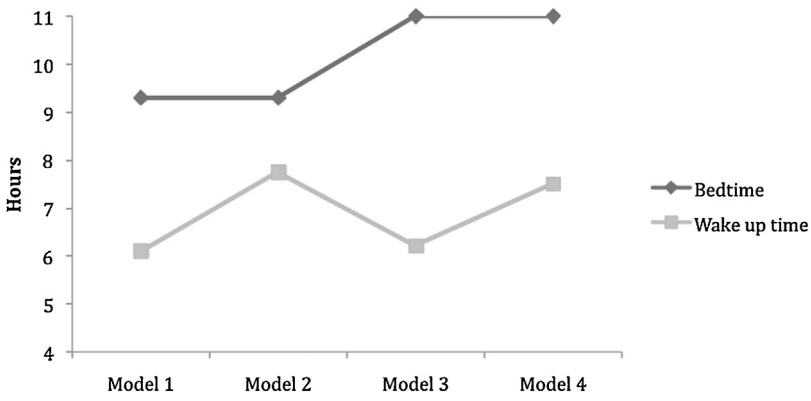


**Fig. 1.** Bedtimes and wake up times across the four categories in adults. Model 1: Early-bed/Early-rise, model 2: Early-bed/Late-rise, model 3: Late-bed/Early-rise, model 4: Late-bed/Late-rise.

**Table 2**
Comparison of time spent in physical activity and sedentary activities across four categories in adults (mean ± SD).

| | Model 1 | Model 2 | Model 3 | Model 4 | *P* |
|---|---|---|---|---|---|
| *N* | 119 | 171 | 100 | 119 | |
| Physical activity (min week$^{-1}$) | 390 ± 450 | 256 ± 233 | 386 ± 282 | 276 ± 270 | 0.02 |
| Watching TV (min day$^{-1}$) | 218 ± 131 | 180 ± 125 | 220 ± 143 | 225 ± 130 | NS |
| Computer/Video games (min day$^{-1}$) | 131 ± 178 | 129 ± 71 | 163 ± 116 | 172 ± 130 | NS |
| Total sedentary activities (h week$^{-1}$) | 20.25 ± 12.25 | 17.75 ± 12.76 | 23.82 ± 14.89 | 27.20 ± 17.46 | 0.01 |

Model 1: Early-bed/Early-rise, model 2: Early-bed/Late-rise, model 3: Late-bed/Early-rise, model 4: Late-bed/Late-rise.

**Table 3**
Physical characteristics across four categories in adults.

| | Model 1 | Model 2 | Model 3 | Model 4 |
|---|---|---|---|---|
| *N* | 119 | 171 | 100 | 119 |
| Males | 63 | 90 | 70 | 74 |
| Females | 56 | 81 | 30 | 45 |
| Age (years) | 41 ± 10.10 | 39 ± 10.79 | 41 ± 9.82 | 38 ± 9.48 |
| Overweight (%) | 31.1 | 23.4 | 29 | 34.5 |
| Obese (%) | 13.5 | 20.4 | 15 | 15.1 |
| Overweight + obese (%) | 44.6 | 43.8 | 44 | 49.6 |

Model 1: Early-bed/Early-rise, model 2: Early-bed/Late-rise, model 3: Late-bed/Early-rise, model 4: Late-bed/Late-rise.

### 3.2. Physical activity

Time spent in physical activity is presented in Table 2. Significant difference was found in physical activity ($p < 0.02$). Participants who wake up earlier are more active than those who rise late. Participants with the greatest sleep duration were least active ($p < 0.02$).

Adjusted for sleep duration and weight status, the odds ratios for low physical activity were 1.0 for Early-bed/Early-rise, 1.5 for Early-bed/Late-rise, 1.1 for Late-bed/Early-rise, and 1.3 for Late-bed/Late-rise.

### 3.3. Sedentary behaviors

Significant difference in sedentary behavior was also found between different sleep models (Table 2). Participants who slept later spent more time in sedentary activities than those in the Early rise groups ($p < 0.01$). Late bedtime participants were engaged in sedentary activities an average of 25 h and 30 min per week against 19 h per week in early bedtime participants.

Adjusted for sleep duration and weight status, the odds ratios for high time sedentary behavior were 1.1 for Early-bed/Early-rise, 1.3 for Early-bed/Late-rise, 1.5 for Late-bed/Early-rise, and 1.7 for Late-bed/Late-rise.

### 3.4. Physical characteristics

Gender, age, overweight and obesity are presented for each sleep model (Table 3, Fig. 2). The number of participants who were overweight/obese was globally higher in the late bedtime groups. Participants with late bedtime were more likely

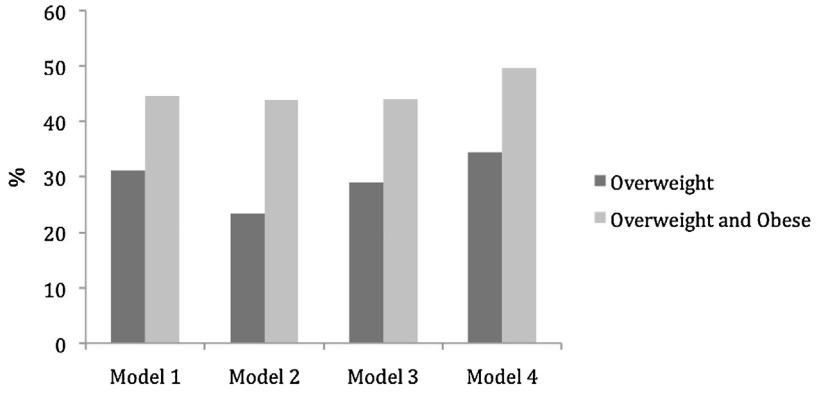


**Fig. 2.** Percentage of overweight and obese across four categories in adults. Model 1: Early-bed/Early-rise, model 2: Early-bed/Late-rise, model 3: Late-bed/Early-rise, model 4: Late-bed/Late-rise.

overweight or obese plus overweight ($p < 0.05$) compared with early bedtime. The highest percentage of obese participants was in the Early-bed/Late rise group ($p < 0.05$). The number of obese/overweight participants was also higher in Late-bed/Late rise group.

Adjusted for sleep duration, the odds ratios for overweight and obesity were 1.5 for Early-bed/Early-rise, 1.1 for Early-bed/Late-rise, 1.4 for Late-bed/Early-rise, and 1.6 for Late-bed/Late-rise.

## 4. Discussion

Several studies reported a higher risk for overweight or obese in intellectually disabled populations compared to non-disabled ones (Hove, 2004; Mikulovic et al., 2014; Rimmer & Yamaki, 2006; Robertson et al., 2000; Stedman & Leland, 2010). In this context, there is a real need to explore the potential factors contributing to this high prevalence. Previously, many studies demonstrated that a decrease of physical activity and a poor diet were responsible of the increase of overweight and obesity (Hove, 2004; Mikulovic et al., 2014; Rimmer & Yamaki, 2006; Robertson et al., 2000; Stedman & Leland, 2010). However, other studies of non-disabled people have concluded that sleep habits, independent of sleep duration, has an impact on overweight and obesity status (Gaina et al., 2006; Olds et al., 2011; Schubert & Randler, 2008). In addition, the similar results have been found in adolescents with intellectual deficiency (Vanhelst et al., 2013). The purpose of this study was to investigate the relationship between sleep timing behavior and overweight/obesity, physical activity patterns and sedentary behaviors among French adults with intellectual disabilities. The study produced three main findings. Sleep habits are associated to physical activity patterns, to the sedentary behaviors and the weight status even after considering potential confounding factor, the sleep duration.

Several authors suggested that chronic partial sleep loss may increase the risk of obesity and weight gain (Patel & Hu, 2008; Van Cauter, Spiegel, Tasali, & Leproult, 2008). Patel and Hu (2008) explained that short sleep duration may impact on dietary intake and energy expenditure. Sleep deprivation enhances energy intake (the increase opportunity to eat and the impact on peripheral regulators of hunger) and decreases energy expenditure (less energy for physical activity due to the tiredness). Our findings showed that the higher percentage of overweight and obese adult was found in the Late-bed/Late-rise group while the sleep duration was longer compared to the other groups. We found also that adults in this same group (Late-bed/Late-rise) have the highest time spent in sedentary activities. A potential explanation for this high time spent in sedentary activity is the participants sleeping later, increase the opportunity to watch TV (225 min $day^{-1}$). Similarly, the participants in the Late-bed/Late-rise group are also less active than adults in Early-bed-Early-rise and Late-bed/Early-rise groups. The wake up time later might contribute to the decrease of the daily physical activity. Results from this study suggest therefore, that sleep timing behavior independently of the sleep duration, has an impact on the physical activity patterns, sedentary behaviors and the anthropometric measurements (weight status). Our results are in agreement with previous studies performed in youth with intellectual deficiency or not (Olds et al., 2011; Vanhelst et al., 2013). Indeed, Olds et al. (2011) concluded that Late-bed/Late-rise adolescents have more screen time, less moderate-to-vigorous physical activity, and are more likely to be overweight or obese than Early-bed/Early rise participants ($p < 0.0001$) in spite of similar sleep durations. In adolescents with intellectual deficiency, Vanhelst et al. (2013) showed that youth in the late-bed group were more likely overweight and obese ($p < 0.05$) and adolescents who woke up early were more active than those from the Late rise group ($p < 0.001$).

Although daily energy intake was not determined in the present study, two previous studies in adolescents and adults suggest that sleep-timing behavior may be a better predictor of overweight and obesity than sleep duration (Fleig & Randler, 2009; Schubert & Randler, 2008). Fleig and Randler (2009) concluded that chronotype was associated with eating behavior and showed that participants who rose earlier exhibited a healthier and more regular lifestyle. Schubert and Randler (2008) suggested that chronotype influenced eating behavior, and showed higher body mass index in children and adolescents who go to bed late.

Strengths of the present study are the large sample size of adults, and that the study is the first to examine the possibility of a new potential mechanism responsible for overweight or obesity in adults with intellectual deficiency. A limitation of the study is the subjectivity of the assessment of the physical activity and sedentary behaviors. In addition, we did not collect information about dietary habits or daily energy intake. Further investigations should include the energy intake assessed by a dietitian and an objective assessment of the physical activity, such as the accelerometry (Vanhelst, Béghin, Bui-Xuan, & Mikulovic, 2012; Vanhelst, Hardy, Gottrand, & Béghin, 2012).

In summary, our findings suggest that sleep habits may explain, in part, overweight and obesity in adults with intellectual deficiency. Sleep habits, independently of sleep duration, should be considered in future interventions and health promotion strategies in adults with intellectual deficiency. The data obtained from this study contribute to develop a better understanding on the health in disabled adults and policies to develop in a near future.

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